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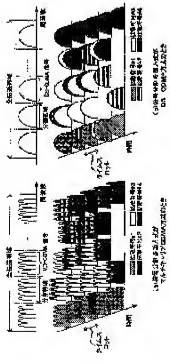
(71)Applicant : YRP MOBILE TELECOMMUNICATIONS KEY TECH RES LAB CO LTD
(72)Inventor : SATO FUMIYO
KAMIO YUKIHIDE

(54) SYSTEM AND APPARATUS FOR RADIO COMMUNICATION



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a system and an apparatus wherein the effect of multipath waves due to a wide band is reduced, many users are accommodated and an efficient transmission is realized.
SOLUTION: The total transmission band is divided into a plurality of bands. An access operation by a frequency division which uses the divided bands as a unit, an access operation by a code division in the respective divided bands, and an access operation by a time division by constituting a time slot in a time-base direction are used. Consequently, the access operations can be controlled flexibly. The code division may be either (a) a multicarrier CDMA system or (b) a DS-CDMA system. When the frequency of the divided bands to be used, the number of the divided bands, the number of diffusion codes to be used or the number of time slots to be allocated is changed, the transmission capacity of the system and the apparatus can be made variable.

CLAIMS

[Claim(s)]
[Claim 1]A radio communications system having a means to perform zone division multiplex by making into a unit a zone which divided all the transmission bands of a system into plurality, a means to perform code division multiplexing in said each divided zone, and a means to perform Time Division Multiplexing using a time slot constituted by time base direction.
[Claim 2]The radio communications system according to claim 1, wherein said code division multiplexing is a multi-carrier CDMA system which makes one chip of a spread code correspond to each subcarrier of two or more subcarriers contained in the zone concerned.
[Claim 3]The radio communications system according to claim 1, wherein said code division multiplexing is a diffusion CDMA system directly.
[Claim 4]The radio communications system according to any one of claims 1 to 3 having a means to perform frequency hopping among said two or more divided zones.
[Claim 5]Said radio communications system according to any one of claims 1 to 4 having a means to change the number of said divided zone which is assigned to the user concerned and said divided zones, the number of said spread codes, or the number of said time slots, according to a kind or propagation environment of information to transmit.
[Claim 6]Radio communication equipment which transmits a signal using 1 of the zones which divided all the transmission bands of a system characterized by comprising the following into plurality, or two or more zones.
A control means which chooses a zone used of said two or more zones.
A means to divide transmit information into a number corresponding to the number of said selected zones.
A diffusion means which performs diffusion modulation using a spread code specified by said control means to said each divided transmit information.
Based on a control signal from said control means, a carrier frequency signal corresponding to a zone chosen from signalling frequency corresponding to said two or more divided zones is chosen, A subcarrier selecting means outputted to specified timing, and a means to generate a sending signal by multiplying by a carrier frequency signal chosen as an output of said diffusion means from said subcarrier selecting means.

[Claim 7]The radio communication equipment according to claim 6, wherein said diffusion means is what performs diffusion by a multi carrier system which makes one chip of a spread code correspond to each subcarrier of two or more subcarriers contained in the zone concerned.
[Claim 8]The radio communication equipment according to claim 6, wherein said diffusion means is what performs directly diffusion which multiplies the input signal concerned by a spread code.
[Claim 9]The radio communication equipment according to any one of claims 6 to 8, wherein said control means changes said zone to be used for every predetermined time and performs frequency hopping.
[Claim 10]The radio communication equipment according to any one of claims 6 to 9,

wherein said control means changes the number of said divided zone which is assigned to the user concerned and said divided zones, the number of spread codes, or said timing according to a kind or propagation environment of information to transmit.
[Claim 11]Radio communication equipment which receives a signal transmitted using 1 of the zones into which plurality divided all the transmission bands of a system characterized by comprising the following, or two or more zones.
A control means which supplies a control signal for choosing a zone corresponding to a signal which should be received among divided zones of said plurality.
A zone selecting means which outputs an input signal of a zone selected according to a control signal from said control means to specified timing.
A back-diffusion-of-gas means which carries out back-diffusion of gas of the input signal from said zone selecting means using a spread code specified by said control means.
A means to generate receipt information from an output of said back-diffusion-of-gas means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the radio communications system and radio communication equipment which realize a flexible and efficient multi-access about the multi-access method which communicates using Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex.
[0002]
[Description of the Prior Art]In recent years, also in the mobile communications field, the demand of the multimedia communication which unifies, transmits and receives the data of various kinds, such as a sound, a text, and a picture, is increasing, therefore high-speed transmission is needed. To accommodate many users extremely with the spread of mobile communications in the limited frequency band is desired. However, at mobile communications, frequency selective fading occurs by a multipass wave, and receiving big influence especially is known for the high-speed transmission which needs broadband transmission.
[0003]. As one of the measure of this, made the multi-access possible in the typical rectangular frequency multiplexing (Orthogonal Frequency Division Multiplex:OFDM) method of frequency-division multiplex which is a formula on the other hand. the mobile communication system using a zone division multi-access (Band Division Multiple Access:BDMA) method is proposed (Fujita -- 1000 **) Hiroaki Takahashi, Kazuyuki Sakota, Mitsuihiro Suzuki, the "basic transmission characteristic of a BDMA method", Shingaku Giho RCS99-2, pp.7 April, 1999 [-12 or]. The spectrum of this BDMA method is shown in drawing 5. A BDMA method is a communication method which used Frequency-Division-Multiplexing access and a Time Division Multiple Access. Each subcarrier in a BDMA method is transmitting the information which should be transmitted by performing QPSK modulation etc. A user who divides all the transmission bands into plurality, and is different using the divided zone is accommodated.
[0004]On the other hand, the multi-carrier CDMA (Multi-Carrier CDMA) method which

combined code division multiplex access (Code Division Multiple Access:CDMA) with the OFDM communication method is known. What a multi-carrier CDMA system assigns each chip of a spread code to each subcarrier from the feature, and performs CDMA on a frequency axis, It is divided roughly into what arranges the signal diffused on the time-axis with the conventional direct diffusion CDMA (Direct Sequence CDMA:DS-CDMA) method to a frequency axis as one subcarrier. Each spectrum of the conventional multi-carrier CDMA system and DS-CDMA system is shown in drawing 6. QPSK modulation etc. are performed to the information which should be transmitted in a multi-carrier CDMA system, it is diffused using the spread code which was further assigned for every user and which intersects perpendicularly mutually, and is arranged on a frequency axis. In the multi-carrier CDMA system which performs CDMA on a frequency axis, each chip (C_1 - C_n) of a spread code supports each subcarrier (f_1 - f_n) of an OFDM signal.

[0005]

[Problem(s) to be Solved by the Invention]Although the BDMA method which is one of an OFDM communication method and multi-access methods is strong to a delayed wave as mentioned above, and it is a method which has the tolerance to frequency selective fading, When it broadband-izes from the necessity for high-speed transmission and the subcarrier number increases, there is a problem that the device which realizes it increases extremely. Especially the fast Fourier transformation equipment (FFT) used in transceiving equipment and reverse fast Fourier transformation equipment (IFFT) need the multiplier of the square individual of the number of subcarriers to be used. In a CDMA system, when broadband-ization is performed for realization of high-speed transmission, the influence of a multipass wave increases and there is a problem of degrading communication performance. Or the compensating device of the degradation is needed and the scale of a receiving set increases. There is also a problem that modeling of the propagation path accompanying broadband-izing, separation of a multipass, and composition become difficult. In multimedia communication, by the difference in a user's communication purpose. Two or more access speed is realized, it is required for the speed to be also able to change accommodative, easy control realizes variable access speed, and efficient transmission and the efficient access control which use frequency and electric power effectively are expected. In a cellular communication system, the measure against the performance degradation by the interference signal from other than a self-cell is also important.

[0006]Then, this invention aims at offer of the radio communications system which can realize realization of high access speed, flexible access control, and interference reduction in view of the above-mentioned problem. This invention aims at offer of the radio communication equipment which can realize variable access speed and can realize reduction and efficient power use of a receiver scale in a mobile station with simple composition.

[0007]

[Means for Solving the Problem]To achieve the above objects, a radio communications system of this invention, It has a means to perform zone division multiplex by making into a unit a zone which divided all the transmission bands of a system into plurality, a means to perform code division multiplexing in said each divided zone, and a means to perform Time Division Multiplexing using a time slot constituted by time base direction.

Said said code division multiplexing is good for each subcarrier of two or more subcarriers contained in the zone concerned also as a multi-carrier CDMA system to which one chip of a spread code is made to correspond, or a direct spread system. It may be made to have a means to perform frequency hopping among said two or more divided zones. It may be made to have a means to change the number of said divided zone which is assigned to the user concerned and said divided zones, the number of said spread codes, or the number of said time slots further again, according to a kind or propagation environment of information to transmit.

[0008]A control means which chooses further again a zone which radio communication equipment of this invention is radio communication equipment which transmits a signal using 1 of the zones which divided all the transmission bands of a system into plurality, or two or more zones, and is used of said two or more zones, A means to divide transmit information into a number corresponding to the number of said selected zones, A diffusion means which performs diffusion modulation using a spread code specified by said control means to said each divided transmit information, Based on a control signal from said control means, a carrier frequency signal corresponding to a zone chosen from signalling frequency corresponding to said two or more divided zones is chosen, It has a subcarrier selecting means outputted to specified timing, and a means to generate a sending signal by multiplying by a carrier frequency signal chosen as an output of said diffusion means from said subcarrier selecting means. Said diffusion means may perform directly a thing which performs diffusion by a multi carrier system which makes one chip of a spread code correspond to each subcarrier of two or more subcarriers contained in the zone concerned, or diffusion which multiplies the input signal concerned by a spread code further again. Said control means may change said zone to be used for every predetermined time, and may perform frequency hopping further again. Said control means may change the number of said divided zone which is assigned to the user concerned and said divided zones, the number of spread codes, or said timing further again according to a kind or propagation environment of information to transmit.

[0009]Other radio communication equipments of this invention are radio communication equipments which receive a signal transmitted using 1 of the zones into which plurality divided all the transmission bands of a system, or two or more zones further again, A control means which supplies a control signal for choosing a zone corresponding to a signal which should be received among divided zones of said plurality, A zone selecting means which outputs an input signal of a zone selected according to a control signal from said control means to specified timing, It has a back-diffusion-of-gas means which carries out back-diffusion of gas of the input signal from said zone selecting means using a spread code specified by said control means, and a means to generate receipt information from an output of said back-diffusion-of-gas means.

[0010]According to a radio communications system and radio communication equipment of such this invention, by using three kinds of multi-access methods, Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex, very flexible access control becomes possible and a multi-access with sufficient transmission efficiency in mobile communications becomes possible. Frequency utilization efficiency can be raised by using for a code-division-multiplexing means a multi-carrier CDMA system which uses and diffuses numerals on a frequency axis. Since all the wireless transfer zones are divided into plurality and it also enabled it to transmit and receive them

independently, by [which divided] receiving independently for every zone, degradation by a multipass wave can be suppressed and access speed can be improved efficiently. A scale of fast Fourier transformation equipment (FFT) of a transmitter-receiver and the inverse Fourier transform machine (IFFT) can be reduced, and a weight saving and low power consumption of a device can be attained in a mobile station. It becomes reducible [considering it as a simple equipment configuration, and transmission power] by taking composition of the required number of partitions with maximum transmission speed of a request for the communication purpose further again. Access speed can be changed by changing a frequency band of a zone used for transmission, the number of zones, the number of numerals, or hour corresponding (the number of time slots to assign) that carried out time sharing again further again according to a kind or propagation environment of information to transmit. Since the composition which makes such access speed variable does not need to change a modulator, it can be considered as simple composition. By performing frequency hopping further again, improving communication performance by the frequency diversity effect and measures against an interference wave in multi-cell environment can be taken.

[0011]

[Embodiment of the Invention]The spectrum by the radio communications system of this invention is shown in drawing 1. The spectrum when drawing 1 (a) uses a multi-carrier CDMA system and drawing 1 (b) uses DS-CDMA system as code division multiplex is shown. All the transmission bands of a system are divided into plurality, and let each divided zone (partition-bands region) be the communication band which intersected perpendicularly namely, became independent with the filter etc. so that you may illustrate. And it makes possible zone division multiplex (Frequency Division Multiplexing) by making this partition-bands region into a unit. Code division multiplexing is performed in each divided zone by the multi-carrier CDMA system (drawing 1 (a)) or DS-CDMA system (drawing 1 (b)) spread in the direction of a frequency axis using a spread code. In drawing 1, the difference in the handle of a spectrum shows a different spread code, i.e., a different user. The frequency band of the partition-bands region to be used and the kind of numerals to be used are determined according to the communicating state of propagation environment or other users. In the time-axis, by dividing time, a time slot is constituted and it makes time-sharing multiplex possible. Thus, in the radio communications system of this invention, flexible access control is realized by performing access to which three kinds, Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex, are changed accommodative.

[0012]Transmission capacity can be changed by changing some of the divided frequency band of a zone to be used, number of the divided zones, number of the spread codes to be used, number of time slots that communicates, or those all according to each user's communication purpose. That is, the user with large transmission capacity uses many zones and spread codes, and the user with small transmission capacity uses one zone and one spread code. Thus, transmission capacity can be made variable. When determining the frequency band of a partition-bands region, the zone used with a random number or a random code is determined, and frequency hopping is performed by changing a frequency band in time. Thereby, the frequency diversity effect is acquired and the influence by the interference from other cells can be reduced in multi-cell environment.

[0013]An example of the transmission section and receive section which constitute the radio communications system of this invention is explained using drawing 2 - drawing 4. Drawing 2 shows the composition of the transmission and reception section of the radio communications system by this invention, drawing 2 (a) is a block diagram showing the composition of a transmission section, and drawing 2 (b) is a block diagram showing the composition of a receive section. In the transmission section of drawing 2 (a), 1070 is a controller and specifies the number of said partition-bands regions used for the transmission from this transmission section, the frequency band of each partition-bands region, assignment of said time slot, a kind, number of diffusion signals to be used, etc.
[0014]According to the number of zones which transmits simultaneously, serial parallel conversion of the information modulation symbols 1010 to which the abnormal conditions of QPSK modulation etc. were performed is carried out with series / parallel-conversion machine 1020. This parallel number is specified by said controller 1070, and drawing 2 shows the time of the number of the zones which transmit simultaneously being 4. The parallelized information modulation symbols are diffused using the spread code 1080 specified by the controller 1070 with the diffusers 1031-1034. As mentioned above, as this diffusion method, they may be any of a multi-carrier CDMA system or DS-CDMA system. The composition of the diffusers 1031-1034 in an all directions type and a corresponding back-diffusion-of-gas machine is mentioned later.
[0015]The carrier frequency signal 1120 corresponding to each partition-bands region can take advantaging in the multipliers 1051-1054 to the output signal of the diffusers 1031-1034. Here, the carrier frequency signal 1120 is chosen in the subcarrier selecting part 1040 by the subcarrier control signal 1090 from [from the signalling frequency 1110 beforehand prepared so that each partition-bands region might intersect perpendicularly by a frequency axis] the controller 1070. In drawing 2 (a), only several 4 of the partition-bands region which f_1 to f_8 is prepared and transmits the signalling frequency 1110 in parallel is chosen (f_{c1} - f_{c4}). The subcarrier selecting part 1040 outputs said selected carrier frequency 1120 to the timing corresponding to the time slot assigned to this transmission section with the subcarrier control signal from said control section 1070. The signal of each partition-bands region is compounded by the adding machine 1055, and the sending signal 1060 is generated. Information, including the number of the partition-bands regions in said control section 1070 to be used, the frequency band of each partition-bands region, assignment of said time slot, the kind of spread code to be used, a number, etc., is notified to the control section 2070 of a receiver via a control channel etc.
[0016]In the receive section which shows drawing 2 (b), the zone selecting parts 2021-2024 choose the partition-bands region received with the zone selection control signal 2070 from the controller 2060, and divide the input signal 2010 into the signal of each partition-bands region. The zone selecting parts 2021-2024 are constituted by a band-pass filter, the multiplier which carries out frequency conversion to a baseband belt with the carrier frequency signal of the zone selected in the assigned time slot, etc. Back-diffusion of gas of the baseband signal for every separated zone is carried out using the spread code 2080 with the back-diffusion-of-gas machines 2031-2034 of the same method as the code division multiplex of the transmitting side, and with the parallel/serial-conversion machine 2040, it becomes the original information modulation symbols 2050, restores to this, and obtains information data.

[0017]Although only the four diffusers 1031-1034 corresponding to four zones to be used and the multipliers 1051-1054 were illustrated in above-mentioned drawing 2 (a) and the four zone selecting parts 2021-2024 and the back-diffusion-of-gas machines 2031-2034 were illustrated in (b), It has actually the diffuser and back-diffusion-of-gas machine of a maximum number which may be used, and is used by control of said controller 1070 and the controller 2060, choosing the device of the number currently then assigned. Said controller 1070 can change assignment etc. of the frequency band of said zone to be used, the number of zones, the kind of spread code to be used and a number, and a time slot accommodative according to a user's communication purpose or propagation environment. Thereby, transmission capacity can be made variable. The information changed in this case is notified to the controller 2060 of a receiver through a control channel etc. The function to perform frequency hopping which changes the partition-bands region which uses and chooses a random number and a random code as said controller 1070 and the controller 2060 for every predetermined time in sync with said time slot can be given. Thereby, the frequency diversity effect is expectable.
[0018]Drawing 3 is a figure showing the example of 1 composition of said diffusers 1031-1034 in the case of being based on a multi-carrier CDMA system, and said back-diffusion-of-gas machines 2031-2034. The diffuser by the multi-carrier CDMA system of drawing 3 (a) is used as the diffusers 1031-1034 of said drawing 2. The information modulation symbols 3010 of this zone inputted from said series / parallel-conversion machine 1020, It is reproduced by the duplicate parts 3020 by the chip number of the spread code 3040, and the multiplication of the information modulation symbols and each chips 3041-3044 of a spread code which were reproduced is carried out by the multipliers 3031-3034. Drawing 3 shows the time of the length of a spread code, i.e., the chip number of a spread code, being 4. Here, the kind of spread code is determined by said controller 1070. The reverse fast Fourier transformation equipment (IFFT) 3050 arranges the information modulation symbols by which the chip of the spread code was able to multiply to the subcarrier which intersects perpendicularly on a frequency axis, and changes them into the signal of a time-axis. The guard period which deletes the influence of a multipass wave by the guard period aedeagus 3060 is inserted, and it becomes the output signal 3070 of a diffuser. This output signal 3070 is outputted to that to which it corresponds of said multipliers 1051-1054.
[0019](b) of drawing 3 is a figure showing the example of composition of the back-diffusion-of-gas machine in the case of a multi-carrier CDMA system. The received input signal 3110 of the partition-bands region concerned where said zone selecting parts 2021-2024 were selected is deleted in a guard period with the guard period deletion machine 3120, and is inputted into the fast Fourier transformation equipment (FFT) 3130. Here, it is returned to the subcarrier on a frequency axis from the signal of a time-axis, and with each chip and the multipliers 3151-3154 of the spread code 3140, multiplication is carried out, respectively, back-diffusion of gas is carried out, and it is compounded by the composing device 3160, and becomes the output signal 3170 of a back-diffusion-of-gas machine. This output signal 3170 is inputted into said parallel/serial-conversion machine 2040.
[0020]Drawing 4 is a figure showing the example of 1 composition of said diffusers 1031-1034 at the time of adopting DS-CDMA system, and said back-diffusion-of-gas machines 2031-2034. The diffuser by DS-CDMA system of this drawing 4 (a) may be

used as the diffusers 1031-1034 of said drawing 2. In this case, the parallelized information modulation symbols are diffused on a time-axis, respectively. In the diffuser shown in (a) of drawing 4, the multiplication of the information modulation symbols 4010 corresponding to this inputted zone is carried out with the spread code 4020 and the multiplier 4030, and the output signal 4040 of this diffuser is acquired. 1 information symbol period is equivalent to the spread code cycle (this example four chips) so that it may illustrate. The kind of this diffusion signal is determined by said controller 1070. In the back-diffusion-of-gas machine shown in drawing 4 (b), the multiplication of the received input signal 4110 of the partition-bands region concerned where said zone selecting parts 2021-2024 were selected is carried out to the spread code of said transmitting side, and the same spread code 4130 with the multiplier 4020, By integrating the integrator 4140, the correlation output of the input signal 4110 and the spread code 4130 is obtained, and it becomes the output signal 4150 of this back-diffusion-of-gas machine.

[0021]By using the above composition, it is possible to transmit and receive the spectrum shown in drawing 1. In the above explanation, although the case where the multi-carrier CDMA system which makes one chip of a spread code correspond to each subcarrier, and a diffusion CDMA system were directly adopted as a CDMA system for every partition-bands region was explained, it is not restricted to this. As mentioned above, various kinds of methods, such as a method which arranges the signal diffused on the time-axis with DS-CDMA system to a frequency axis as one subcarrier, are known by the multi-carrier CDMA system, and such a method may be adopted as it.

[0022]

[Effect of the Invention]As explained above, according to the radio communications system and radio communication equipment of this invention, flexible access control is realizable by using frequency-division multiplex, a time-sharing multiplex mode, and three code division multiplex kinds. Since each bandwidth divided since the broadband wireless transfer zone was divided into plurality is made in a narrow-band and makes each the zone which can communicate independently rather than all the original transmission bands, interference by a multipass can be reduced and communication performance is not degraded. Since one independent communication band turns into a narrow-band, it is possible to raise reduction and power efficiency of a device scale. if it is alike and is based on this invention using the multi-carrier CDMA system as code division multiplex, the guard belt region width between the partition-bands regions for making the divided zone into the independent communication band can be reduced, and frequency utilization efficiency is good. In the terminal unit whose maximum transmission speed may be small, since the scale and transmission power of a device can be reduced, the device of small size and low power consumption is realizable. Transmission capacity can be made variable by changing the number of the partition-bands regions to be used, or the number of numerals to be used further again according to a user's communication purpose or propagation environment. Since the composition which makes such access speed variable does not need to change a modulator, it can be considered as simple composition. Especially when this is applied to a mobile station, it can reduce the composition of a transmitter-receiver, and the power efficiency of this is also good. By performing frequency hopping to which the frequency band of the partition-bands region which communicates is changed at random in time further again,

the frequency diversity effect can be acquired and communication performance can be improved. Performances -- the interference from other cells can be reduced in multi-cell environment -- can be improved by doing in this way.

TECHNICAL FIELD

[Field of the Invention]This invention relates to the radio communications system and radio communication equipment which realize a flexible and efficient multi-access about the multi-access method which communicates using Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex.

PRIOR ART

[Description of the Prior Art]In recent years, also in the mobile communications field, the demand of the multimedia communication which unifies, transmits and receives the data of various kinds, such as a sound, a text, and a picture, is increasing, therefore high-speed transmission is needed. To accommodate many users extremely with the spread of mobile communications in the limited frequency band is desired. However, at mobile communications, frequency selective fading occurs by a multipass wave, and receiving big influence especially is known for the high-speed transmission which needs broadband transmission.

[0003]. As one of the measure of this, made the multi-access possible in the typical rectangular frequency multiplexing (Orthogonal Frequency Division Multiplex:OFDM) method of frequency-division multiplex which is a formula on the other hand. the mobile communication system using a zone division multi-access (Band Division Multiple Access:BDMA) method is proposed (Fujita -- 1000 **) Hiroaki Takahashi, Kazuyuki Sakota, Mitsuihiro Suzuki, the "basic transmission characteristic of a BDMA method", Shingaku Giho RCS99-2, pp.7 April, 1999 [-12 or]. The spectrum of this BDMA method is shown in drawing 5. A BDMA method is a communication method which used Frequency-Division-Multiplexing access and a Time Division Multiple Access. Each subcarrier in a BDMA method is transmitting the information which should be transmitted by performing QPSK modulation etc. A user who divides all the transmission bands into plurality, and is different using the divided zone is accommodated.

[0004]On the other hand, the multi-carrier CDMA (Multi-Carrier CDMA) method which combined code division multiplex access (Code Division Multiple Access:CDMA) with the OFDM communication method is known. What a multi-carrier CDMA system assigns each chip of a spread code to each subcarrier from the feature, and performs CDMA on a frequency axis, It is divided roughly into what arranges the signal diffused on the time-axis with the conventional direct diffusion CDMA (Direct Sequence CDMA:DS-CDMA) method to a frequency axis as one subcarrier. Each spectrum of the conventional multi-carrier CDMA system and DS-CDMA system is shown in drawing 6. QPSK modulation etc. are performed to the information which should be transmitted in a multi-carrier CDMA system, it is diffused using the spread code which was further assigned for every user and which intersects perpendicularly mutually, and is arranged on

a frequency axis. In the multi-carrier CDMA system which performs CDMA on a frequency axis, each chip (C_1 - C_n) of a spread code supports each subcarrier (f_1 - f_n) of an OFDM signal.

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, according to the radio communications system and radio communication equipment of this invention, flexible access control is realizable by using frequency-division multiplex, a time-sharing multiplex mode, and three code division multiplex kinds. Since each bandwidth divided since the broadband wireless transfer zone was divided into plurality is made in a narrow-band and makes each the zone which can communicate independently rather than all the original transmission bands, interference by a multipass can be reduced and communication performance is not degraded. Since one independent communication band turns into a narrow-band, it is possible to raise reduction and power efficiency of a device scale. if it is alike and is based on this invention using the multi-carrier CDMA system as code division multiplex, the guard belt region width between the partition-bands regions for making the divided zone into the independent communication band can be reduced, and frequency utilization efficiency is good. In the terminal unit whose maximum transmission speed may be small, since the scale and transmission power of a device can be reduced, the device of small size and low power consumption is realizable. Transmission capacity can be made variable by changing the number of the partition-bands regions to be used, or the number of numerals to be used further again according to a user's communication purpose or propagation environment. Since the composition which makes such access speed variable does not need to change a modulator, it can be considered as simple composition. Especially when this is applied to a mobile station, it can reduce the composition of a transmitter-receiver, and the power efficiency of this is also good. By performing frequency hopping to which the frequency band of the partition-bands region which communicates is changed at random in time further again, the frequency diversity effect can be acquired and communication performance can be improved. Performances -- the interference from other cells can be reduced in multi-cell environment -- can be improved by doing in this way.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]Although the BDMA method which is one of an OFDM communication method and multi-access methods is strong to a delayed wave as mentioned above, and it is a method which has the tolerance to frequency selective fading, When it broadband-izes from the necessity for high-speed transmission and the subcarrier number increases, there is a problem that the device which realizes it increases extremely. Especially the fast Fourier transformation equipment (FFT) used in transceiving equipment and reverse fast Fourier transformation equipment (IFFT) need the multiplier of the square individual of the number of subcarriers to be used. In a CDMA system, when broadband-ization is performed for realization of high-speed

transmission, the influence of a multipass wave increases and there is a problem of degrading communication performance. Or the compensating device of the degradation is needed and the scale of a receiving set increases. There is also a problem that modeling of the propagation path accompanying broadband-izing, separation of a multipass, and composition become difficult. In multimedia communication, by the difference in a user's communication purpose. Two or more access speed is realized, it is required for the speed to be also able to change accommodative, easy control realizes variable access speed, and efficient transmission and the efficient access control which use frequency and electric power effectively are expected. In a cellular communication system, the measure against the performance degradation by the interference signal from other than a self-cell is also important.

[0006]Then, this invention aims at offer of the radio communications system which can realize realization of high access speed, flexible access control, and interference reduction in view of the above-mentioned problem. This invention aims at offer of the radio communication equipment which can realize variable access speed and can realize reduction and efficient power use of a receiver scale in a mobile station with simple composition.

MEANS

[Means for Solving the Problem]To achieve the above objects, a radio communications system of this invention, It has a means to perform zone division multiplex by making into a unit a zone which divided all the transmission bands of a system into plurality, a means to perform code division multiplexing in said each divided zone, and a means to perform Time Division Multiplexing using a time slot constituted by time base direction. Said said code division multiplexing is good for each subcarrier of two or more subcarriers contained in the zone concerned also as a multi-carrier CDMA system to which one chip of a spread code is made to correspond, or a direct spread system. It may be made to have a means to perform frequency hopping among said two or more divided zones. It may be made to have a means to change the number of said divided zone which is assigned to the user concerned and said divided zones, the number of said spread codes, or the number of said time slots further again, according to a kind or propagation environment of information to transmit.

[0008]A control means which chooses further again a zone which radio communication equipment of this invention is radio communication equipment which transmits a signal using 1 of the zones which divided all the transmission bands of a system into plurality, or two or more zones, and is used of said two or more zones, A means to divide transmit information into a number corresponding to the number of said selected zones, A diffusion means which performs diffusion modulation using a spread code specified by said control means to said each divided transmit information, Based on a control signal from said control means, a carrier frequency signal corresponding to a zone chosen from signalling frequency corresponding to said two or more divided zones is chosen, It has a subcarrier selecting means outputted to specified timing, and a means to generate a sending signal by multiplying by a carrier frequency signal chosen as an output of said diffusion means from said subcarrier selecting means. Said diffusion means may perform

directly a thing which performs diffusion by a multi carrier system which makes one chip of a spread code correspond to each subcarrier of two or more subcarriers contained in the zone concerned, or diffusion which multiplies the input signal concerned by a spread code further again. Said control means may change said zone to be used for every predetermined time, and may perform frequency hopping further again. Said control means may change the number of said divided zone which is assigned to the user concerned and said divided zones, the number of spread codes, or said timing further again according to a kind or propagation environment of information to transmit.
[0009]Other radio communication equipments of this invention are radio communication equipments which receive a signal transmitted using 1 of the zones into which plurality divided all the transmission bands of a system, or two or more zones further again, A control means which supplies a control signal for choosing a zone corresponding to a signal which should be received among divided zones of said plurality, A zone selecting means which outputs an input signal of a zone selected according to a control signal from said control means to specified timing, It has a back-diffusion-of-gas means which carries out back-diffusion of gas of the input signal from said zone selecting means using a spread code specified by said control means, and a means to generate receipt information from an output of said back-diffusion-of-gas means.
[0010]According to a radio communications system and radio communication equipment of such this invention, by using three kinds of multi-access methods, Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex, very flexible access control becomes possible and a multi-access with sufficient transmission efficiency in mobile communications becomes possible. Frequency utilization efficiency can be raised by using for a code-division-multiplexing means a multi-carrier CDMA system which uses and diffuses numerals on a frequency axis. Since all the wireless transfer zones are divided into plurality and it also enabled it to transmit and receive them independently, by [which divided] receiving independently for every zone, degradation by a multipass wave can be suppressed and access speed can be improved efficiently. A scale of fast Fourier transformation equipment (FFT) of a transmitter-receiver and the inverse Fourier transform machine (IFFT) can be reduced, and a weight saving and low power consumption of a device can be attained in a mobile station. It becomes reducible [considering it as a simple equipment configuration, and transmission power] by taking composition of the required number of partitions with maximum transmission speed of a request for the communication purpose further again. Access speed can be changed by changing a frequency band of a zone used for transmission, the number of zones, the number of numerals, or hour corresponding (the number of time slots to assign) that carried out time sharing again further again according to a kind or propagation environment of information to transmit. Since the composition which makes such access speed variable does not need to change a modulator, it can be considered as simple composition. By performing frequency hopping further again, improving communication performance by the frequency diversity effect and measures against an interference wave in multi-cell environment can be taken.
[0011]
[Embodiment of the Invention]The spectrum by the radio communications system of this invention is shown in drawing 1. The spectrum when drawing 1 (a) uses a multi-carrier CDMA system and drawing 1 (b) uses DS-CDMA system as code division multiplex is

shown. All the transmission bands of a system are divided into plurality, and let each divided zone (partition-bands region) be the communication band which intersected perpendicularly namely, became independent with the filter etc. so that you may illustrate. And it makes possible zone division multiplex (Frequency Division Multiplexing) by making this partition-bands region into a unit. Code division multiplexing is performed in each divided zone by the multi-carrier CDMA system (drawing 1 (a)) or DS-CDMA system (drawing 1 (b)) spread in the direction of a frequency axis using a spread code. In drawing 1, the difference in the handle of a spectrum shows a different spread code, i.e., a different user. The frequency band of the partition-bands region to be used and the kind of numerals to be used are determined according to the communicating state of propagation environment or other users. In the time-axis, by dividing time, a time slot is constituted and it makes time-sharing multiplex possible. Thus, in the radio communications system of this invention, flexible access control is realized by performing access to which three kinds, Frequency Division Multiplexing, code division multiplexing, and time-sharing multiplex, are changed accommodative.

[0012]Transmission capacity can be changed by changing some of the divided frequency band of a zone to be used, number of the divided zones, number of the spread codes to be used, number of time slots that communicates, or those all according to each user's communication purpose. That is, the user with large transmission capacity uses many zones and spread codes, and the user with small transmission capacity uses one zone and one spread code. Thus, transmission capacity can be made variable. When determining the frequency band of a partition-bands region, the zone used with a random number or a random code is determined, and frequency hopping is performed by changing a frequency band in time. Thereby, the frequency diversity effect is acquired and the influence by the interference from other cells can be reduced in multi-cell environment.

[0013]An example of the transmission section and receive section which constitute the radio communications system of this invention is explained using drawing 2 - drawing 4. Drawing 2 shows the composition of the transmission and reception section of the radio communications system by this invention, drawing 2 (a) is a block diagram showing the composition of a transmission section, and drawing 2 (b) is a block diagram showing the composition of a receive section. In the transmission section of drawing 2 (a), 1070 is a controller and specifies the number of said partition-bands regions used for the transmission from this transmission section, the frequency band of each partition-bands region, assignment of said time slot, a kind, number of diffusion signals to be used, etc.

[0014]According to the number of zones which transmits simultaneously, serial parallel conversion of the information modulation symbols 1010 to which the abnormal conditions of QPSK modulation etc. were performed is carried out with series / parallel-conversion machine 1020. This parallel number is specified by said controller 1070, and drawing 2 shows the time of the number of the zones which transmit simultaneously being 4. The parallelized information modulation symbols are diffused using the spread code 1080 specified by the controller 1070 with the diffusers 1031-1034. As mentioned above, as this diffusion method, they may be any of a multi-carrier CDMA system or DS-CDMA system. The composition of the diffusers 1031-1034 in an all directions type and a corresponding back-diffusion-of-gas machine is mentioned later.

[0015]The carrier frequency signal 1120 corresponding to each partition-bands region

can take advantaging in the multipliers 1051-1054 to the output signal of the diffusers 1031-1034. Here, the carrier frequency signal 1120 is chosen in the subcarrier selecting part 1040 by the subcarrier control signal 1090 from [from the signalling frequency 1110 beforehand prepared so that each partition-bands region might intersect perpendicularly by a frequency axis] the controller 1070. In drawing 2 (a), only several 4 of the partition-bands region which f_1 to f_8 is prepared and transmits the signalling frequency 1110 in parallel is chosen (f_{c1} - f_{c4}). The subcarrier selecting part 1040 outputs said selected carrier frequency 1120 to the timing corresponding to the time slot assigned to this transmission section with the subcarrier control signal from said control section 1070. The signal of each partition-bands region is compounded by the adding machine 1055, and the sending signal 1060 is generated. Information, including the number of the partition-bands regions in said control section 1070 to be used, the frequency band of each partition-bands region, assignment of said time slot, the kind of spread code to be used, a number, etc., is notified to the control section 2070 of a receiver via a control channel etc.

[0016]In the receive section which shows drawing 2 (b), the zone selecting parts 2021-2024 choose the partition-bands region received with the zone selection control signal 2070 from the controller 2060, and divide the input signal 2010 into the signal of each partition-bands region. The zone selecting parts 2021-2024 are constituted by a band-pass filter, the multiplier which carries out frequency conversion to a baseband belt with the carrier frequency signal of the zone selected in the assigned time slot, etc. Back-diffusion of gas of the baseband signal for every separated zone is carried out using the spread code 2080 with the back-diffusion-of-gas machines 2031-2034 of the same method as the code division multiplex of the transmitting side, and with the parallel/serial-conversion machine 2040, it becomes the original information modulation symbols 2050, restores to this, and obtains information data.

[0017]Although only the four diffusers 1031-1034 corresponding to four zones to be used and the multipliers 1051-1054 were illustrated in above-mentioned drawing 2 (a) and the four zone selecting parts 2021-2024 and the back-diffusion-of-gas machines 2031-2034 were illustrated in (b), It has actually the diffuser and back-diffusion-of-gas machine of a maximum number which may be used, and is used by control of said controller 1070 and the controller 2060, choosing the device of the number currently then assigned. Said controller 1070 can change assignment etc. of the frequency band of said zone to be used, the number of zones, the kind of spread code to be used and a number, and a time slot accommodative according to a user's communication purpose or propagation environment. Thereby, transmission capacity can be made variable. The information changed in this case is notified to the controller 2060 of a receiver through a control channel etc. The function to perform frequency hopping which changes the partition-bands region which uses and chooses a random number and a random code as said controller 1070 and the controller 2060 for every predetermined time in sync with said time slot can be given. Thereby, the frequency diversity effect is expectable.

[0018]Drawing 3 is a figure showing the example of 1 composition of said diffusers 1031-1034 in the case of being based on a multi-carrier CDMA system, and said back-diffusion-of-gas machines 2031-2034. The diffuser by the multi-carrier CDMA system of drawing 3 (a) is used as the diffusers 1031-1034 of said drawing 2. The information modulation symbols 3010 of this zone inputted from said series / parallel-conversion

machine 1020, It is reproduced by the duplicate parts 3020 by the chip number of the spread code 3040, and the multiplication of the information modulation symbols and each chips 3041-3044 of a spread code which were reproduced is carried out by the multipliers 3031-3034. Drawing 3 shows the time of the length of a spread code, i.e., the chip number of a spread code, being 4. Here, the kind of spread code is determined by said controller 1070. The reverse fast Fourier transformation equipment (IFFT) 3050 arranges the information modulation symbols by which the chip of the spread code was able to multiply to the subcarrier which intersects perpendicularly on a frequency axis, and changes them into the signal of a time-axis. The guard period which deletes the influence of a multipass wave by the guard period aedeagus 3060 is inserted, and it becomes the output signal 3070 of a diffuser. This output signal 3070 is outputted to that to which it corresponds of said multipliers 1051-1054.

[0019](b) of drawing 3 is a figure showing the example of composition of the back-diffusion-of-gas machine in the case of a multi-carrier CDMA system. The received input signal 3110 of the partition-bands region concerned where said zone selecting parts 2021-2024 were selected is deleted in a guard period with the guard period deletion machine 3120, and is inputted into the fast Fourier transformation equipment (FFT) 3130. Here, it is returned to the subcarrier on a frequency axis from the signal of a time-axis, and with each chip and the multipliers 3151-3154 of the spread code 3140, multiplication is carried out, respectively, back-diffusion of gas is carried out, and it is compounded by the composing device 3160, and becomes the output signal 3170 of a back-diffusion-of-gas machine. This output signal 3170 is inputted into said parallel/serial-conversion machine 2040.

[0020]Drawing 4 is a figure showing the example of 1 composition of said diffusers 1031-1034 at the time of adopting DS-CDMA system, and said back-diffusion-of-gas machines 2031-2034. The diffuser by DS-CDMA system of this drawing 4 (a) may be used as the diffusers 1031-1034 of said drawing 2. In this case, the parallelized information modulation symbols are diffused on a time-axis, respectively. In the diffuser shown in (a) of drawing 4, the multiplication of the information modulation symbols 4010 corresponding to this inputted zone is carried out with the spread code 4020 and the multiplier 4030, and the output signal 4040 of this diffuser is acquired. 1 information symbol period is equivalent to the spread code cycle (this example four chips) so that it may illustrate. The kind of this diffusion signal is determined by said controller 1070. In the back-diffusion-of-gas machine shown in drawing 4 (b), the multiplication of the received input signal 4110 of the partition-bands region concerned where said zone selecting parts 2021-2024 were selected is carried out to the spread code of said transmitting side, and the same spread code 4130 with the multiplier 4020, By integrating the integrator 4140, the correlation output of the input signal 4110 and the spread code 4130 is obtained, and it becomes the output signal 4150 of this back-diffusion-of-gas machine.

[0021]By using the above composition, it is possible to transmit and receive the spectrum shown in drawing 1. In the above explanation, although the case where the multi-carrier CDMA system which makes one chip of a spread code correspond to each subcarrier, and a diffusion CDMA system were directly adopted as a CDMA system for every partition-bands region was explained, it is not restricted to this. As mentioned above, various kinds of methods, such as a method which arranges the signal diffused on the time-axis with

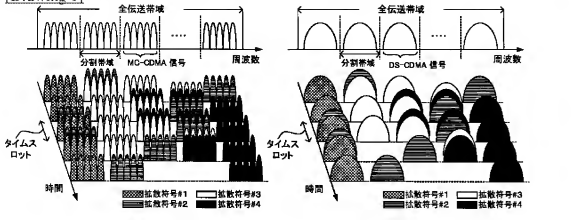
DS-CDMA system to a frequency axis as one subcarrier, are known by the multi-carrier CDMA system, and such a method may be adopted as it.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a figure showing the spectrum of the radio communications system of this invention, and is a figure showing the time of (a) using multi-carrier CDMA and (b) using DS-CDMA as code division multiplex.
[Drawing 2]It is a block diagram showing the example of 1 composition of the transmission section in the radio communications system of this invention, and a receive section, and is a figure in which (a) shows a transmission section and (b) shows the composition of a receive section.
[Drawing 3]It is a block diagram showing the example of composition of the diffused part in the embodiment using a multi-carrier CDMA system as code division multiplex, and a back-diffusion-of-gas part.
[Drawing 4]It is a block diagram showing the example of composition of the diffused part in the embodiment using DS-CDMA system as code division multiplex, and a back-diffusion-of-gas part.
[Drawing 5]It is a figure showing the spectrum of a zone division multi-access (BDMA) method.
[Drawing 6]It is a figure showing the spectrum of the conventional multi-carrier CDMA system and DS-CDMA system.
[Description of Notations]
1010 Information symbol
1020 Series / parallel-conversion machine
1031-1034 Diffuser
1040 Subcarrier selecting part
1051-1054 Multiplier
1055 Adding machine
1060 Sending signal
1070 Controller
2010 Input signal
2021-2024 Zone selecting part
2031-2034 Back-diffusion-of-gas machine
2040 Parallel/serial-conversion machine
2050 Information symbol
2060 Controller
3020 Duplicate part
3050 Reverse fast Fourier transformation equipment
3060 Guard period aedeagus
3120 Guard period deletion machine
3130 Fast Fourier transformation equipment
3160 Composing device

DRAWINGS

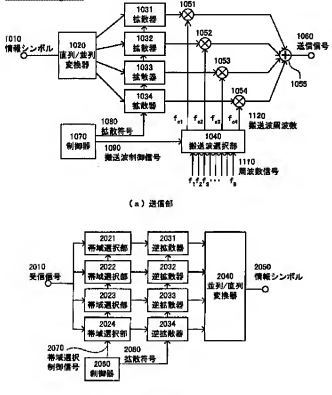
[Drawing 1]



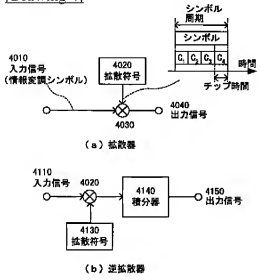
(a)符号分割多重方式が
マルチキャリアCDMA方式のとき

(b)符号分割多重方式が
DS−CDMA方式のとき

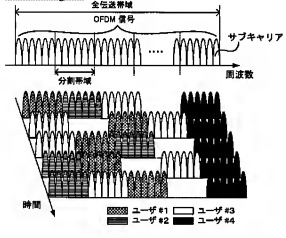
[Drawing 2]



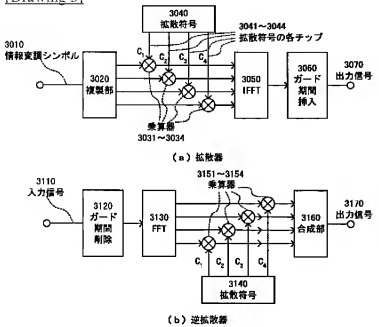
[Drawing 4]



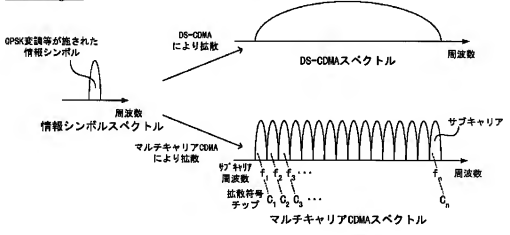
[Drawing 5]



[Drawing 3]



[Drawing 6]



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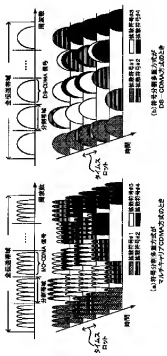
(71)出願人　395022546
株式会社ワイ・アール・ピー移動通信基盤技術研究所
神奈川県横須賀市光の丘３番４号
(72)発明者　佐藤　文代
神奈川県横須賀市光の丘３番４号　株式会社ワイ・アール・ピー移動通信基盤技術研究所内
(74)代理人　100106459
弁理士　高橋　英生　（外３名）

最終頁に続く

(54)【発明の名称】　無線通信システム及び無線通信装置

(57)【要約】
【課題】　広帯域化にともなうマルチパス波の影響を少なくし、極めて多くのユーザを収容し、効率的な伝送を実現する。
【解決手段】　全伝送帯域を複数の帯域に分割し、その分割された帯域を単位とする周波数分割によるアクセス、各分割された帯域における符号分割によるアクセス及び時間軸方向にタイムスロットを構成し、時間分割によるアクセスを用いることにより柔軟なアクセス制御を可能とする。ここで、前記符号分割は、（ａ）のマルチキャリアＣＤＭＡ方式、あるいは（ｂ）のＤＳ－ＣＤＭＡ方式のいずれでもよい。また使用する分割帯域の周波数、分割帯域の数、使用する拡散符号の数や割り当てるタイムスロット数を変えることにより伝送容量を可変とすることができる。



【特許請求の範囲】

【請求項１】　システムの全伝送帯域を複数に分割した帯域を単位として帯域分割多重を行なう手段、前記分割された各帯域において符号分割多重を行なう手段、および、時間軸方向に構成されたタイムスロットを用いて時分割多重を行なう手段を有することを特徴とする無線通信システム。

【請求項２】　前記符号分割多重は、当該帯域に含まれる複数のサブキャリアの各サブキャリアに拡散符号の１チップを対応させるマルチキャリアＣＤＭＡ方式であることを特徴とする請求項１記載の無線通信システム。

【請求項３】　前記符号分割多重は、直接拡散ＣＤＭＡ方式であることを特徴とする請求項１記載の無線通信システム。

【請求項４】　前記分割された複数の帯域間で周波数ホッピングを行なう手段を有することを特徴とする請求項１～３のいずれかに記載の無線通信システム。

【請求項５】　送信する情報の種類もしくは伝搬環境に応じて、当該ユーザに割り当てる前記分割された帯域、前記分割された帯域の数、前記拡散符号の数あるいは前記タイムスロットの数を変化させる手段を有することを特徴とする前記請求項１～４のいずれかに記載の無線通信システム。

【請求項６】　システムの全伝送帯域を複数に分割した帯域のうちの１又は複数の帯域を用いて信号を送信する無線通信装置であって、

前記複数の帯域のうちの使用する帯域を選択する制御手段と、

送信情報を前記選択された帯域の数に対応する数に分割する手段と、

前記分割されたそれぞれの送信情報に対して前記制御手段により指定された拡散符号を用いて拡散変調を行なう拡散手段と、

前記制御手段からの制御信号に基づいて、前記分割された複数の帯域に対応する周波数信号から選択された帯域に対応する搬送波周波数信号を選択して、指定されたタイミングで出力する搬送波選択手段と、

前記拡散手段の出力に前記搬送波選択手段からの選択された搬送波周波数信号を乗じることにより送信信号を生成する手段とを有することを特徴とする無線通信装置。

【請求項７】　前記拡散手段は、当該帯域に含まれる複数のサブキャリアの各サブキャリアに拡散符号の１チップを対応させるマルチキャリア方式による拡散を行なうものであることを特徴とする請求項６記載の無線通信装置。

【請求項８】　前記拡散手段は、当該入力信号に拡散符号を乗ずる直接拡散を行なうものであることを特徴とする請求項６記載の無線通信装置。

【請求項９】　前記制御手段は、前記使用する帯域を所定の時間毎に変更して周波数ホッピングを行なうことを特徴とする請求項６～８のいずれかに記載の無線通信装置。

【請求項１０】　前記制御手段は、送信する情報の種類あるいは伝搬環境に応じて、当該ユーザに割り当てる前記分割された帯域、前記分割された帯域の数、拡散符号の数あるいは前記タイミングを変化させることを特徴とする請求項６～９のいずれかに記載の無線通信装置。

【請求項１１】　システムの全伝送帯域を複数の分割した帯域のうちの１又は複数の帯域を用いて伝送される信号を受信する無線通信装置であって、

前記複数の分割された帯域のうち受信すべき信号に対応する帯域を選択するための制御信号を供給する制御手段と、

前記制御手段からの制御信号に応じて、指定されたタイミングで選択された帯域の受信信号を出力する帯域選択手段と、

前記帯域選択手段からの受信信号を前記制御手段により指定された拡散符号を用いて逆拡散する逆拡散手段と、

前記逆拡散手段の出力から受信情報を生成する手段とを有することを特徴とする無線通信装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、周波数分割多重、符号分割多重および時間分割多重を用いて通信を行う多重アクセス方式に関し、柔軟かつ効率的な多重アクセスを実現する無線通信システムおよび無線通信装置に関するものである。

【０００２】

【従来の技術】近年、移動通信分野においても、音声、テキスト、画像等の様々な種類のデータを統合して送受信するマルチメディア通信の要求が高まっており、そのため高速伝送が必要とされている。また、移動通信の普及に伴い、限られた周波数帯域で極めて多数のユーザを収容することが望まれている。しかしながら、移動通信では、マルチパス波により周波数選択性フェージングが発生し、広帯域な伝送を必要とする高速伝送では、特に大きな影響を受けることが知られている。

【０００３】この対策の一つとして、周波数分割多重方式の代表的な一方式である直交周波数多重（Orthogonal Frequency Division Multiplex：ＯＦＤＭ）方式において多重アクセスを可能とした、帯域分割多重アクセス（Band Division Multiple Access：ＢＤＭＡ）方式を用いた移動通信システムが提案されている（藤田千裕、高橋宏彰、迫田和之、鈴木三博、“ＢＤＭＡ方式の基本伝送特性”、信学技報RCS99-2、pp.7-12、1999年4月）。このＢＤＭＡ方式のスペクトルを図５に示す。ＢＤＭＡ方式は周波数分割多重アクセスと時分割多重アクセスとを用いた通信方式である。ＢＤＭＡ方式におけるそれぞれのサブキャリアはＱＰＳＫ変調等を施すことにより送信すべき情報を伝送している。全伝送帯域を複数

に分割し、分割した帯域を用いて異なるユーザを収容する。

【０００４】一方、ＯＦＤＭ通信方式に符号分割多重アクセス（Code Division Multiple Access：ＣＤＭＡ）を組み合わせたマルチキャリアＣＤＭＡ（Multi-Carrier CDMA）方式が知られている。マルチキャリアＣＤＭＡ方式は、その特徴から、各サブキャリアに拡散符号の各チップを割り当て、周波数軸上にＣＤＭＡを行うものと、従来の直接拡散ＣＤＭＡ（Direct Sequence CDMA：ＤＳ－ＣＤＭＡ）方式により時間軸上に拡散した信号を一つのサブキャリアとして周波数軸に配置するものに大別される。従来のマルチキャリアＣＤＭＡ方式とＤＳ－ＣＤＭＡ方式のそれぞれのスペクトルを図６に示す。マルチキャリアＣＤＭＡ方式において送信すべき情報は、ＱＰＳＫ変調等を施され、さらにユーザ毎に割り当てられた互いに直交する拡散符号を用いて拡散され、周波数軸上に配置される。周波数軸上にＣＤＭＡを行なうマルチキャリアＣＤＭＡ方式では、拡散符号の各チップ（C_1～C_n）がＯＦＤＭ信号の各サブキャリア（f_1～f_n）に対応している。

【０００５】

【発明が解決しようとする課題】ＯＦＤＭ通信方式及びその多重アクセス方式の一つであるＢＤＭＡ方式は、前述したように遅延波に強く、周波数選択性フェージングへの耐性を有する方式であるが、高速伝送の必要性から広帯域化し、そのサブキャリア本数が多くなると、それを実現する装置が極めて増大するという問題がある。特に、送受信装置の中で用いられる高速フーリエ変換器（ＦＦＴ）と逆高速フーリエ変換器（ＩＦＦＴ）は、使用するサブキャリア数の２乗個の乗算器を必要とする。また、ＣＤＭＡ方式では、高速伝送の実現のため広帯域化を行うと、マルチパス波の影響が増大し、通信性能を劣化させるという問題がある。あるいは、その劣化の補償装置が必要となり、受信装置の規模が増大する。また、広帯域化に伴う伝搬路のモデル化、マルチパスの分離、合成が困難となるという問題もある。さらに、マルチメディア通信では、ユーザの通信目的の違いにより、複数の伝送速度を実現し、適応的にその速度も変化可能であることが必要であり、簡単な制御により可変伝送速度を実現し、周波数及び電力を有効に利用する効率的な伝送及び効率的なアクセス制御が期待されている。さらに、セルラ方式においては、自セル以外からの干渉信号による性能劣化の対策も重要である。

【０００６】そこで、本発明は上記した問題に鑑みて、高伝送速度の実現、柔軟なアクセス制御、及び干渉低減を実現することのできる無線通信システムの提供を目的としている。また、本発明は、簡易な構成で可変伝送速度を実現でき、移動局においては受信機規模の縮小や効率的電力使用を実現することのできる無線通信装置の提供を目的としている。

【０００７】

【課題を解決するための手段】上記目的を達成するために、本発明の無線通信システムは、システムの全伝送帯域を複数に分割した帯域を単位として帯域分割多重を行なう手段、前記分割された各帯域において符号分割多重を行なう手段、および、時間軸方向に構成されたタイムスロットを用いて時分割多重を行なう手段を有するものである。また、前記前記符号分割多重は、当該帯域に含まれる複数のサブキャリアの各サブキャリアに拡散符号の１チップを対応させるマルチキャリアＣＤＭＡ方式、あるいは、直接拡散方式による符号分割多重を行なう手段、および、前記分割された複数の帯域間で周波数ホッピングを行なう手段を有するようにしてもよい。さらにまた、送信する情報の種類もしくは伝搬環境に応じて、当該ユーザに割り当てる前記分割された帯域、前記分割された帯域の数、前記拡散符号の数あるいは前記タイムスロットの数を変化させる手段を有するようにしてもよい。

【０００８】さらにまた、本発明の無線通信装置は、システムの全伝送帯域を複数に分割した帯域のうちの１又は複数の帯域を用いて信号を送信する無線通信装置であって、前記複数の帯域のうちの使用する帯域を選択する制御手段と、送信情報を前記選択された帯域の数に対応する数に分割する手段と、前記分割されたそれぞれの送信情報に対して前記制御手段により指定された拡散符号を用いて拡散変調を行なう拡散手段と、前記制御手段からの制御信号に基づいて、前記分割された複数の帯域に対応する周波数信号から選択された帯域に対応する搬送波周波数信号を選択して、指定されたタイミングで出力する搬送波選択手段と、前記拡散手段の出力に前記搬送波選択手段からの選択された搬送波周波数信号を乗じることにより送信信号を生成する手段とを有するものである。さらにまた、前記拡散手段は、当該帯域に含まれる複数のサブキャリアの各サブキャリアに拡散符号の１チップを対応させるマルチキャリア方式による拡散を行なうもの、あるいは、当該入力信号に拡散符号を乗ずる直接拡散を行なうものであってもよい。さらにまた、前記制御手段は、前記使用する帯域を所定の時間毎に変更して周波数ホッピングを行なうものであってもよい。さらにまた、前記制御手段は、送信する情報の種類あるいは伝搬環境に応じて、当該ユーザに割り当てる前記分割された帯域、前記分割された帯域の数、拡散符号の数あるいは前記タイミングを変化させるものであってもよい。

【０００９】さらにまた、本発明の他の無線通信装置は、システムの全伝送帯域を複数の分割した帯域のうちの１又は複数の帯域を用いて伝送される信号を受信する無線通信装置であって、前記複数の分割された帯域のうち受信すべき信号に対応する帯域を選択するための制御信号を供給する制御手段と、前記制御手段からの制御信号に応じて、指定されたタイミングで選択された帯域の受信信号を出力する帯域選択手段と、前記帯域選択手段

からの受信信号を前記制御手段により指定された拡散符号を用いて逆拡散する逆拡散手段と、前記逆拡散手段の出力から受信情報を生成する手段とを有するものである。

【００１０】このような本発明の無線通信システムおよび無線通信装置によれば、周波数分割多重、符号分割多重及び時間分割多重の３種類の多重アクセス方式を用いることにより、極めて柔軟なアクセス制御が可能となり、移動通信における伝送効率のよい多重アクセスが可能となる。また、符号分割多重手段に周波数軸上に符号を用いて拡散するマルチキャリアＣＤＭＡ方式を利用することにより、周波数利用効率を高めることができる。さらに、全無線伝送帯域を複数に分割し独立に送受信することもできるようにしたので、分割した帯域毎に独立して受信することによって、マルチパス波による劣化を抑えることができ、伝送速度を効率的に向上できる。また、送受信機の高速フーリエ変換器（ＦＦＴ）と逆フーリエ変換器（ＩＦＦＴ）の規模を縮小することができ、移動局においては装置の軽量化及び低消費電力化を図ることができる。さらにまた、通信目的による所望の最大伝送速度により、必要な分割数の構成をとることにより、簡易な装置構成とすることおよび送信電力の削減が可能となる。さらにまた、送信する情報の種類もしくは伝搬環境に応じて、伝送に使用する帯域の周波数帯、帯域の数、符号の数、あるいはまた時間分割した通信時間（割り当てるタイムスロットの数）を変更することにより、伝送速度を変更することができる。このような伝送速度を可変にする構成は、変調器を変更する必要がないため、簡易な構成とすることができる。さらにまた周波数ホッピングを行うことにより、周波数ダイバーシチ効果により通信性能を向上することと、またマルチセル環境での干渉波対策をすることができる。

【００１１】

【発明の実施の形態】本発明の無線通信システムによるスペクトルを図１に示す。図１（ａ）は符号分割多重方式としてマルチキャリアＣＤＭＡ方式を、図１（ｂ）はＤＳ-ＣＤＭＡ方式を用いたときのスペクトルを示している。図示するように、システムの全伝送帯域は複数に分割され、分割された各帯域（分割帯域）は、フィルタ等により、直交した、すなわち独立した通信帯域とされる。そして、この分割帯域を単位として帯域分割多重（周波数分割多重）を可能としている。また、それぞれの分割された帯域では、拡散符号を用いて周波数軸方向に拡散を行うマルチキャリアＣＤＭＡ方式（図１（ａ））あるいはＤＳ－ＣＤＭＡ方式（図１（ｂ））により符号分割多重が行われる。図１において、スペクトルの柄の違いは異なる拡散符号すなわち異なるユーザを示している。使用する分割帯域の周波数帯や使用する符号の種類は伝搬環境や他ユーザの通信状態に応じて決定される。さらに、時間軸において、時間を分割することによってタイムスロットを構成し、時間分割多重を可能としている。このように本発明の無線通信システムでは、周波数分割多重、符号分割多重、時間分割多重の３種類を適応的に変化させるアクセスを行うことにより、柔軟なアクセス制御を実現している。

【００１２】また、各ユーザの通信目的に応じて、使用する分割された帯域の周波数帯、分割された帯域の数、使用する拡散符号の数、通信するタイムスロットの数のいくつかまたはそれらの全てを変更することにより、伝送容量を変化させることができる。すなわち、伝送容量の大きいユーザは多数の帯域や拡散符号を使用し、伝送容量の小さいユーザは一つの帯域と一つの拡散符号を使用する。このようにして伝送容量を可変にすることができる。さらに、分割帯域の周波数帯を決定するときに、乱数やランダム符号によって使用する帯域を決定し、時間的に周波数帯を変化させることで、周波数ホッピングを行う。これにより、周波数ダイバーシチ効果が得られ、またマルチセル環境において、他セルからの干渉による影響を低減することができる。

【００１３】本発明の無線通信システムを構成する送信部および受信部の一例を図２～図４を用いて説明する。図２は、本発明による無線通信システムの送受信部の構成を示し、図２（ａ）は送信部の構成を示すブロック図であり、図２（ｂ）は受信部の構成を示すブロック図である。図２（ａ）の送信部において、１０７０は制御器であり、この送信部からの送信に使用する前記分割帯域の数、各分割帯域の周波数帯、前記タイムスロットの割当、使用する拡散信号の種類や数などを指定する。

【００１４】ＱＰＳＫ変調等の変調が行われた情報変調シンボル１０１０は、直列／並列変換器１０２０によって同時に送信する帯域数に応じて直並列変換される。この並列数は前記制御器１０７０により指定され、図２では同時に送信する帯域の数が４であるときを示している。並列化された情報変調シンボルは、拡散器１０３１～１０３４で制御器１０７０により指定された拡散符号１０８０を用いて拡散される。前述のように、この拡散方式としては、マルチキャリアＣＤＭＡ方式あるいはＤＳ－ＣＤＭＡ方式のいずれであってもよい。なお、各方式における拡散器１０３１～１０３４および対応する逆拡散器の構成については後述する。

【００１５】拡散器１０３１～１０３４の出力信号に対して、各分割帯域に対応した搬送波周波数信号１１２０が乗算器１０５１～１０５４において乗じられる。ここで、搬送波周波数信号１１２０は、各分割帯域が周波数軸で直交するように予め用意された周波数信号１１１０から、制御器１０７０からの搬送波制御信号１０９０によって搬送波選択部１０４０において選択されたものである。図２（ａ）では、周波数信号１１１０はf_1からf_8が用意されていて、並列に送信する分割帯域の数４だけ選択されている（f_{c1}～f_{c4}）。また、搬送波選択

部１０４０は、前記制御部１０７０からの搬送波制御信号により、この送信部に割り当てられたタイムスロットに対応するタイミングで前記選択された搬送波周波数１１２０を出力する。各分割帯域の信号は加算器１０５５により合成され、送信信号１０６０が生成される。なお、前記制御部１０７０における使用する分割帯域の数、各分割帯域の周波数帯、前記タイムスロットの割当、使用する拡散符号の種類や数などの情報は、制御チャネルなどを介して、受信側の制御部２０７０に通知される。

【００１６】図２（ｂ）に示す受信部において、帯域選択部２０２１～２０２４は制御部２０６０からの帯域選択制御信号２０７０により受信する分割帯域を選択して受信信号２０１０を各分割帯域の信号に分離する。帯域選択部２０２１～２０２４は帯域通過フィルタ、割り当てられたタイムスロットにおいて選択された帯域の搬送波周波数信号によりベースバンド帯に周波数変換する乗算器等により構成される。分離された帯域ごとのベースバンド信号は送信側の符号分割多重方式と同じ方式の逆拡散器２０３１～２０３４で拡散符号２０８０を用いて逆拡散され、並列／直列変換器２０４０によって元の情報変調シンボル２０５０になり、これを復調して情報データを得る。

【００１７】なお、上記図２（ａ）においては、使用する４個の帯域に対応する４個の拡散器１０３１～１０３４、乗算器１０５１～１０５４のみを図示し、（ｂ）においては、４個の帯域選択部２０２１～２０２４、逆拡散器２０３１～２０３４を図示したが、実際には、使用する可能性のある最大個数の拡散器や逆拡散器を備え、前記制御部１０７０および制御部２０６０の制御により、そのときに割り当てられている個数の装置を選択して使用する。また、前記制御部１０７０は、ユーザの通信目的あるいは伝搬環境に応じて、前記使用する帯域の周波数帯、帯域の数、使用する拡散符号の種類および数、タイムスロットの割当などを適応的に変更することができる。これにより伝送容量を可変とすることができる。なお、この場合、変更した情報は、制御チャネルなどを通じて受信側の制御部２０６０に通知する。さらに、前記制御部１０７０及び制御部２０６０に乱数やランダム符号を用いて選択する分割帯域を前記タイムスロットに同期した所定時間毎に変更する周波数ホッピングを行なう機能を持たせることができる。これにより、周波数ダイバーシチ効果を期待することができる。

【００１８】図３はマルチキャリアＣＤＭＡ方式による場合における前記拡散器１０３１～１０３４と前記逆拡散器２０３１～２０３４の一構成例を示す図である。前記図２の拡散器１０３１～１０３４として図３（ａ）のマルチキャリアＣＤＭＡ方式による拡散器を用いる。前記直列／並列変換器１０２０から入力されたこの帯域の情報変調シンボル３０１０は、複製部３０２０によって拡散符号３０４０のチップ数分だけ複製され、複製された情報変調シンボルと拡散符号の各チップ３０４１～３０４４が乗算器３０３１～３０３４によって乗算される。図３は、拡散符号の長さ、すなわち拡散符号のチップ数が４のときを示している。ここで、拡散符号の種類は、前記制御部１０７０で決定される。逆高速フーリエ変換器（ＩＦＦＴ）３０５０は、拡散符号のチップが乗じられた情報変調シンボルを周波数軸上で直交するサブキャリアに配置し、時間軸の信号に変換する。ガード期間挿入器３０６０でマルチパス波の影響を削除するガード期間が挿入され、拡散器の出力信号３０７０となる。この出力信号３０７０は前記乗算器１０５１～１０５４のうちの対応するものに出力される。

【００１９】図３の（ｂ）は、マルチキャリアＣＤＭＡ方式の場合の逆拡散器の構成例を示す図である。前記帯域選択部２０２１～２０２４により選択された当該分割帯域の受信入力信号３１１０は、ガード期間削除器３１２０でガード期間を削除され、高速フーリエ変換器（ＦＦＴ）３１３０に入力される。ここで、時間軸の信号から周波数軸上のサブキャリアに戻され、拡散符号３１４０の各チップと乗算器３１５１～３１５４でそれぞれ乗算されて逆拡散され、合成器３１６０で合成され、逆拡散器の出力信号３１７０となる。この出力信号３１７０は、前記並列／直列変換器２０４０に入力される。

【００２０】また、図４は、ＤＳ－ＣＤＭＡ方式を採用した場合における前記拡散器１０３１～１０３４と前記逆拡散器２０３１～２０３４の一構成例を示す図である。前記図２の拡散器１０３１～１０３４としてこの図４（ａ）のＤＳ-ＣＤＭＡ方式による拡散器を使用してもよい。この場合、並列化された情報変調シンボルはそれぞれ時間軸上に拡散される。図４の（ａ）に示す拡散器において、入力されたこの帯域に対応する情報変調シンボル４０１０は、拡散符号４０２０と乗算器４０３０で乗算され、この拡散器の出力信号４０４０が得られる。図示するように、１情報シンボル周期が拡散符号周期（この例では４チップ）に対応している。この拡散信号の種類は、前記制御器１０７０で決定される。図４（ｂ）に示す逆拡散器では、前記帯域選択部２０２１～２０２４により選択された当該分割帯域の受信入力信号４１１０が乗算器４０２０で前記送信側の拡散符号と同一の拡散符号４１３０と乗算され、積分器４１４０で積分されることにより、入力信号４１１０と拡散符号４１３０との相関出力が得られ、この逆拡散器の出力信号４１５０となる。

【００２１】以上の構成を用いることにより、図１に示したスペクトルを送信及び受信することが可能である。なお、以上の説明においては、各分割帯域毎のＣＤＭＡ方式として、各サブキャリアに拡散符号の１チップを対応させるマルチキャリアＣＤＭＡ方式および直接拡散ＣＤＭＡ方式を採用した場合について説明したが、これに

限られることはない。前述のように、マルチキャリアCDMA方式には、DS－CDMA方式により時間軸上に拡散した信号を一つのサブキャリアとして周波数軸に配置する方式など各種の方式が知られており、このような方式を採用してもよい。

【0022】

【発明の効果】以上説明したように、本発明の無線通信システムおよび無線通信装置によれば、周波数分割多重方式、時間分割多重方式、符号分割多重方式の3種類を用いることにより柔軟なアクセス制御を実現することができる。また、広帯域な無線伝送帯域を複数に分割しているため、分割したそれぞれの帯域幅が元の全伝送帯域よりも狭帯域にでき、それぞれを独立して通信可能な帯域としているため、マルチパスによる干渉を低減でき、通信性能を劣化させない。また、一つの独立した通信帯域が狭帯域になるため、装置規模の縮小や電力効率を向上させることが可能である。さらに、符号分割多重方式としてマルチキャリアCDMA方式を用いた本発明によれば、分割した帯域を独立した通信帯域とするための分割帯域間のガード帯域幅を縮小することができ、周波数利用効率が良い。さらに、最大伝送速度が小さくてよい端末装置においては、装置の規模及び送信電力を低減できるため、小型、低消費電力の装置が実現可能である。さらにまた、ユーザの通信目的もしくは伝搬環境に応じて、使用する分割帯域の数あるいは使用する符号の数を変更することにより、伝送容量を可変にすることができる。このような伝送速度を可変にする構成は、変調器を変更する必要がないため、簡易な構成とすることができる。これが、移動局に適用される場合は特に、送受信機の構成を縮小することができ、電力効率も良い。さらにまた、通信する分割帯域の周波数帯を時間的にランダムに変化させる周波数ホッピングを行うことにより、周波数ダイバーシチ効果を得ることができ、通信性能を向上することができる。さらに、このようにすることにより、マルチセル環境において他セルからの干渉を低減できるなど、性能を向上することができる。

【図面の簡単な説明】

【図1】本発明の無線通信システムのスペクトルを示す図であり、符号分割多重方式として（a）はマルチキャリアCDMAを、（b）はDS－CDMAを使用したときを示す図である。

【図2】本発明の無線通信システムにおける送信部及び受信部の一構成例を示すブロック図であり、（a）は送信部、（b）は受信部の構成を示す図である。

【図3】符号分割多重方式としてマルチキャリアCDMA方式を用いる実施の形態における拡散部及び逆拡散部の構成例を示すブロック図である。

【図4】符号分割多重方式としてDS－CDMA方式を用いる実施の形態における拡散部及び逆拡散部の構成例を示すブロック図である。

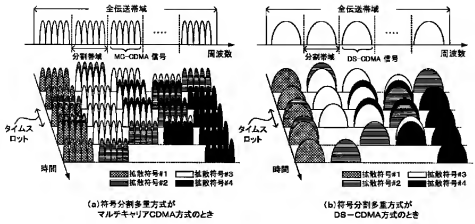
【図5】帯域分割多重アクセス（BDMA）方式のスペクトルを示す図である。

【図6】従来のマルチキャリアCDMA方式とDS－CDMA方式のスペクトルを示す図である。

【符号の説明】

1010　情報シンボル
1020　直列／並列変換器
1031～1034　拡散器
1040　搬送波選択部
1051～1054　乗算器
1055　加算器
1060　送信信号
1070　制御器
2010　受信信号
2021～2024　帯域選択部
2031～2034　逆拡散器
2040　並列／直列変換器
2050　情報シンボル
2060　制御器
3020　複製部
3050　逆高速フーリエ変換器
3060　ガード期間挿入器
3120　ガード期間削除器
3130　高速フーリエ変換器
3160　合成器

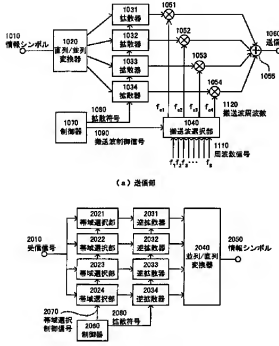
【図1】



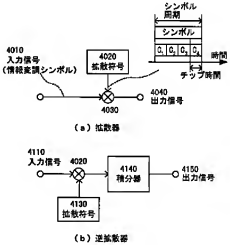
(a)符号分割多重方式がマルチキャリアCDMA方式のとき

(b)符号分割多重方式がDS-CDMA方式のとき

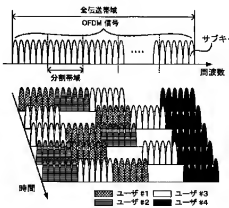
【図2】



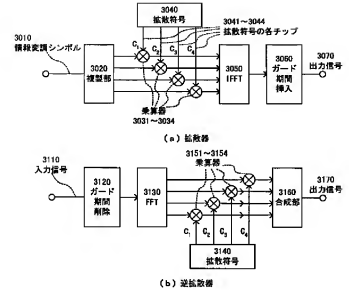
【図4】



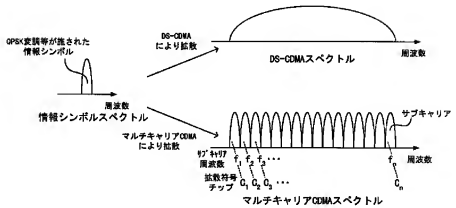
【図5】



【図３】



【図６】



フロントページの続き

(72)発明者　神尾　享秀
神奈川県横須賀市光の丘３番４号　株式会
社ワイ・アール・ピー移動通信基盤技術研
究所内

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